Five-Year Review Report

Third Five-Year Review Report

for

FMC Site

City of Fridley

Anoka County, Minnesota

March 2004

PREPARED BY:

Minnesota Pollution Control Agency
St. Paul, Minnesota

Approved by:

Michael Kanner
Manager, Superfund Section
Minnesota Pollution Control Agency

Date: 3/15/04

Approved by:

for Richard C. Karl
Acting Director, Region 5 Superfund Division
United States Environmental Protection Agency

Date: 17 Mar 04

[This page intentionally left blank.]

TABLE OF CONTENTS

List of Acronyms

ACLs	Alternate Concentration Levels
AMR	Annual Monitoring Report
AOC	Administrative Order of Consent
ARARs	Applicable or Relevant and Appropriate Requirements
BNR	Burlington Northern Railroad
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
COC	Contaminant of Concern
CTF	Containment and Treatment Facility
EPA	United States Environmental Protection Agency
HRL	Health Risk Level
IC	Institutional Control
LMCLs	Listed Maximum Concentration Levels
MCES	Metropolitan Council Environmental Services
MCLs	Maximum Contaminant Levels
MDH	Minnesota Department of Health
MERLA	Minnesota Environmental Liability and Response Act
MPCA	Minnesota Pollution Control Agency
MWW	Minneapolis Water Works
NCP	Nation Oil and Hazardous Substances Pollution Contingency Plan
NIROP	Naval Industrial Reserve Ordnance Plant
NPDES	National Pollutant Discharge Elimination System
NPL	Nation Priorities List
O&M	Operation and Maintenance
OSHA	Occupational Safety and Health Administration
OU	Operable Unit
POTW	Publicly Owned Treatment Works
PRP	Potentially Responsible Party
RA	Remedial Action
RAGS	Risk Assessment Guidance for Superfund
RAL	Recommended Allowable Limit
RAO	Remedial Action Objective
RCRA	Resource Conservation and Recovery Act
RI/FS	Remedial Investigation/Feasibility Study
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
TBCs	To be Considereds
TCE	Trichloroethylene
VOCs	Volatile Organic Compounds
WasteLan	The Regional database related to CERCLIS

Executive Summary

The remedy for the FMC Site located in Fridley, Minnesota, included a combination of hydraulic containment of the ground water plume through ground water extraction wells with discharge of untreated ground water to a publicly owned treatment works, long-term monitoring, and institutional controls or land use restrictions to limit ground water use on and downgradient of the FMC Site. The trigger for this five-year review was the completion date for the previous five-year review.

Ground water extraction was initiated during December 1987 and continues to the present. The ground water extraction remedy is removing VOCs from the unconfined and confined aquifers. The remedy is generally functioning as intended and is protective of human health and the environment in the short-term, although questions remain regarding the long-term protectiveness of the remedy based on issues discussed in this Five-Year Review.

Five-Year Review Summary Form

SITE IDENTIFICATION		
Site name *(from WasteLAN)*: **FMC Corporation**		
EPA ID *(from WasteLAN)*: **MND006481543**		
Region: 5	**State: MN**	**City/County: City of Fridley/Anoka County**
SITE STATUS		
NPL status: Final		
Remediation status (choose all that apply): Operating		
Multiple OUs?* NO	**Construction completion date:** 12 / 15 / 1987	
Has site been put into reuse? NO		
REVIEW STATUS		
Lead agency: State		
Author name: David Douglas		
Author title: Project Manager	**Author affiliation: MN Pollution Control Agency**	
Review period:** 10 / 13 / 2003 to 3 / 30 / 2004		
Date(s) of site inspection: 11 / 4 / 2003		
Type of review: Post-SARA		
Review number: 3 (third)		
Triggering action: Previous Five-Year Review Report		
Triggering action date *(from WasteLAN)*: 3 / 30 / 1999		
Due date *(five years after triggering action date)*: 3 / 30 / 2004		

* ["OU" refers to operable unit.]
** [Review period should correspond to the actual start and end dates of the Five-Year Review in WasteLAN.]

Five-Year Review Summary Form, cont'd.

Issues:

The existing monitoring well network is inadequate to monitor the off-site migration of the contaminant plume in the unconfined and confined aquifers.

There is inadequate data available at the time of preparation of this five-year review report to evaluate the effectiveness of the increased pumping rate at RW3 and RW4 on the capture plume.

Recommendations and Follow-up Actions:

The ground water extraction remedy is removing VOCs from the unconfined and confined aquifers. It is recommended that the ground water remedy continue; however, there are ongoing issues that make it difficult to evaluate the effectiveness of the existing ground water remedy. Implementation of the recommendations listed in Section IX will assist in evaluating and maximizing the efficiency of the remedy.

Protectiveness Statement(s):

The remedy is functioning as intended and is protective of human health and the environment in the short-term. Long-term protectiveness needs to be verified based on the follow-up actions and recommendations. The remedy would be confirmed to be fully protective if recommendations cited in Section IX are implemented so that it can be determined that the performance requirements of the remedy cited in Section IV are being met.

Other Comments:

None

FIVE-YEAR REVIEW REPORT

FMC Corporation Site
Fridley, Minnesota

I. INTRODUCTION

The purpose of the five-year review is to determine whether the remedy at the FMC Corporation Site (FMC Site) is protective of human health and the environment. The methods, findings and conclusions of reviews are documented in Five-Year Review reports. In addition, Five-Year Review reports identify issues during the review, if any, and identify recommendations to address them.

The Agency is preparing this Five-Year Review report pursuant to CERCLA Section 121 and the National Contingency Plan (NCP). CERCLA Section 121 states:

> *If the President selects a remedial action that results in any hazardous substances, pollutants, or contaminants remaining at the site, the President shall review such remedial action no less often than each five years after the initiation of such remedial action to ensure that human health and the environment are being protected by the remedial action being implemented. In addition, if upon such review it is the judgement of the President that action is appropriate at such site in accordance with section [104] or [106], the President shall take or require such action. The President shall report to the Congress a list of facilities for which such review is required, the results of all such reviews, and any actions taken as a result of such actions.*

The Agency interpreted this requirement further in the NCP; 40 CFR Section 300.430(f)(4)(ii) states:

> *If a remedial action is selected that results in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure, the lead agency shall review such action no less often than every five years after initiation of the selected remedial action.*

The Minnesota Pollution Control Agency (MPCA) staff has completed a Five-Year Review of the Remedial Actions (RAs) conducted at the FMC Site in Fridley, Minnesota. This Five-Year Review evaluates whether the RA remains protective of public health, welfare, and the environment and was conducted from October 2003 through March 2004.

This third review focuses on the protectiveness of the FMC Site's RA, sixteen years from the time the RA commenced. This is the second Five-Year Review completed by the MPCA. The first Five-Year Review was completed by EPA on September 30, 1992 and

the second review was completed by MPCA in 1999. EPA concurred on the second review on March 30, 1999.

II. SITE CHRONOLOGY

Table 1: Chronology of Site Events

Date	Event
11/1980	Former FMC employee informed the MPCA of the disposal of industrial and hazardous waste from the 1940's through 1969 on the FMC Site.
12/1980	FMC, at the request of the MPCA, initiated an investigation of the FMC Site.
9/8/1983	The FMC Site was placed on the National Priorities List.
9/10/1986	MPCA executed an FMC Site Enforcement Decision Document under the Minnesota Environmental Liability and Response Act (MERLA) that documented the MPCA's selection of a RA for the contaminated ground water at the FMC Site.
10/28/1986	FMC and the MPCA signed a Response Order by Consent under MERLA for the implementation of the RA.
9/30/1987	Date of the FMC Site Record of Decision (ROD) which documented the USEPA's selection of the RA for the contaminated ground water.
12/7/1987	Initiation of ground water extraction from the extraction wells on the FMC Site.
9/30/1992	Completion of the first Five-Year Review report.
3/30/1999	Completion of the second Five-Year Review report.
1987-present	Ongoing implementation of the RA

III. BACKGROUND

Physical Characteristics

The FMC Site is located along East River Road within the city limits of Fridley in Anoka County, Minnesota (Figure 1 in Appendix A). The FMC Site (formerly owned by FMC Corporation) consists of approximately 18 acres that includes 5 acres that were sold in 1969 to Burlington Northern Railroad (BNR) and 13 acres currently owned by United Defense, L.P. (UDLP) (formerly FMC Corporation) (Figure 2 in Appendix A). BNR constructed a stormwater retention basin on the 5 acre parcel in 1999.

The FMC Site is approximately 1,000 feet east of the Mississippi River and is situated on a flat outwash terrace that is approximately 30 feet above the Mississippi River. The ground water plumes from the FMC Site are predicted to enter the river upgradient of the water intake for the Minneapolis Water Works (MWW). The MWW serves approximately 500,000 people. The MWW service area includes the city of Minneapolis and the cities of Golden Valley, Crystal, New Hope, Columbia Heights, Hilltop, parts of

Bloomington and Edina (Morning Side) as well as the Minneapolis/St. Paul International Airport. The MWW produces an average of 70 million gallons of water per day and an annual average withdrawal from the river of 25 billion gallons.

Adjacent Land and Resource Use

Adjacent land use consists of the Naval Industrial Reserve Ordnance Plant (NIROP) to the north; industrial land use to the south; recreational land use to the west; the MWW property to the southwest; and rail yards and commercial/light industrial to the east. Residential properties are located to the east of the railroad tracks.

Recreational land use to the west consists of Anoka County Riverfront Regional Park and the Mississippi River. The location of nearby populations is limited to residential neighborhoods located approximately 1200 feet east and 1800 feet west of the FMC Site. The neighborhood to the east is located east of the railroad tracks. The neighborhood to the west is located along the west side of the Mississippi River.

History of Contamination

In November 1980, the MPCA staff was informed that there had been disposal of industrial and hazardous waste from the 1940s through 1969 on the FMC Site. The wastes generated from naval ordnance manufacturing included plating wastes, paint, paint sludges, oils, bottom ash, and chlorinated and non-chlorinated solvents.

Beginning in December 1980, at the request of the MPCA, FMC began an investigation of the site. The investigation revealed that soil in the disposal areas was contaminated with volatile organic compounds (VOCs). Forty four drums containing hazardous materials were discovered, removed and disposed.

The ground water was found to be contaminated by a variety of chlorinated and non-chlorinated VOCs; however, trichloroethylene (TCE) was found to constitute approximately 98 percent of the contamination. The contaminated ground water was found to extend from the disposal sites to the Mississippi River in two aquifers, a shallow, unconfined sand and gravel aquifer and a deep, confined sand aquifer.

The MPCA staff conducted a surface water sampling program and found low levels of TCE at the intake to the MWW.

Initial Response

Contaminated soil from the waste disposal areas was excavated. Some of the soil was transported off-site for disposal and the remainder was placed in an on-site Containment and Treatment Facility (CTF). The drums were over-packed and transported off-site for disposal.

In May – June 1983, FMC implemented an interim remedial action (removal action) under terms of an administrative order with MPCA and EPA. The excavated soil was secured in an engineered on-site Containment and Treatment Facility.

Ground water monitoring of the two aquifers was initiated and continues to the present time. The ground water monitoring network includes monitoring wells in the shallow, unconfined aquifer and in the deeper, confined aquifer at both on-site and off-site locations. Problems identified by the MPCA with the adequacy of the off-site monitoring well network remain unaddressed.

A ground water extraction system was installed in 1987 with operation commencing on December 7, 1987. Ground water extraction continues through the present. The ground water extraction system, which consists of five extraction wells (RW1 through RW5), was installed to remove contaminated ground water from the shallow, unconfined sand and gravel aquifer and the deeper, confined sand aquifer (Figure 3 in Appendix A). Two wells were screened in the shallow unconfined aquifer (RW1 and RW2) and three wells were screened in the deeper confined aquifer (RW3, RW4 and RW5). Several weeks after system startup, FMC was allowed to shut down extraction well RW1 when FMC personnel reported the extraction well would "run dry" shortly after startup. Extraction well RW1 has not been able to be used for ground water extraction purposes.

Ground water is discharged to the sanitary sewer. The discharge is monitored by FMC and regulated by the Metropolitan Council Environmental Services (MCES). Treatment of extracted ground water is accomplished at the Metropolitan Wastewater Treatment Facility, a publicly owned treatment works (POTW). The MCES permit restricts total VOC effluent concentrations greater than 10 milligrams per liter (mg/l), with no individual VOC concentration greater than 3 mg/l.

Basis For Taking Action

Hazardous substances that have been detected in each media include:

Soil	Ground Water
1,2-Dichloroethane	1,2-Dichloroethane
Methylene Chloride (Dichloromethane)	1,1-Dichloroethane
Trans-1,2-Dichloroethylene	1,1,1-Trichloroethane
1,1,1-Trichloroethane	Trichloroethylene
Trichloroethylene	1,1-Dichloroethylene
Benzene	Tetrachloroethylene
Ethyl Benzene	Benzene
	Vinyl Chloride*
	Cis 1,1-Dichloroethylene*
	Trans 1,1-Dichoroethylene*
	Ethyl Benzene*
	Xylene*
	Carbon Tetrachloride*
	1,1,2-Trichloroethane*

*These hazardous substances were not cited in the ROD, but have been detected at the FMC Site.

VOC concentrations in the ground water exceed applicable Minnesota Department of Health (MDH) Health Risk Limits (HRLs) and/or EPA Maximum Contaminant Levels (MCLs). The ground water plumes from the FMC Site are predicted to enter the Mississippi River upgradient of the water intake for the MWW. The MWW provides drinking water for approximately 500,000 people in the surrounding communities.

IV. REMEDIAL ACTIONS

Remedy Selection

The FMC Site ROD, dated September 30, 1987, selected the following site RA: hydraulic containment of the ground water plume through ground water extraction wells, discharge of contaminated ground water to a POTW and long-term ground water monitoring. The recommended alternative in the ROD stipulated that "the existing institutional controls and land use are to be used to assure groundwater is not used in land between FMC and BNR lands and the Mississippi River during the periods the extraction system is operating and until the plume is sufficiently dissipated."

The remedial objectives cited in the ROD are meant to minimize ingestion of contaminated ground water and treated river water contaminated by impacted ground water. As stated in the ROD, the goal is to keep the ingestion risks from exceeding 1E-6 additional lifetime cancer deaths at any existing receptor which includes those who consume finished water from the MWW.

In the ROD, the overall objectives cited in Section V are further broken down further in Section VI, "Recommended Alternative." In Section VI, the ROD breaks down the recommended alternative into three components: hydraulic containment; discharge of untreated ground water to the publicly owned treatment works; and long-term monitoring and assigns performance requirements for each of these components. These components are further broken down into the following performance requirements:

- Reduce ground water contamination source areas on the FMC Site;
- Reduce general off-site migration of elevated contaminant levels;
- Reduce the ground water contamination at the FMC Site boundary to the Federal MCLs and/or MDH Recommended Allowable Limits (RALs) for the contaminants of concern (COC) (for example, the MCL for TCE is 5 micrograms per liter (µg/l) at the FMC Site property boundary);

- Reduce the ground water contamination beyond the FMC Site boundary (in the area between the boundary and the Mississippi River) through dissipation of the ground water plume; and

- Discharge the contaminated ground water to the sanitary sewer for treatment at the Metropolitan Wastewater Treatment Facility;

- Implementation of a ground water monitoring system, including:

  - Monitoring extracted ground water to determine flow rate and contaminant concentration;

  - Hydraulic containment monitoring;

  - Monitoring the surficial aquifer and confined aquifer;

  - Monitoring the surficial and confined aquifer near the Mississippi River south of the MWW and Anoka County Park property line; and

  - Monitoring water at the intake to the MWW.

ARAR Review

As stated above, the Five-Year Review is being conducted to determine whether the FMC Site RA remains protective of public health and the environment. The more specific purpose of the reviews is two-fold: (1) to confirm that the remedy as spelled out in the ROD and/or remedial design remains effective at protecting human health and the environment, e.g., the remedy is operating and functioning as designed, institutional controls are in place and are protective and (2) to evaluate whether original cleanup levels remain protective of human health and the environment. ARARs and "To Be Considereds" (TBCs) are key elements in fulfilling these two purposes.

ARARs Cited in the ROD

Safe Drinking Water Act (SDWA) (40 CFR Parts 141 - 146)

Establishes Federal MCLs and Maximum Contaminant Level Goals to protect public drinking water supplies. This ARAR applies to any aquifer that could be used for a public water supply.

In the ROD, EPA stated that the selected remedy will ensure that MCLs or health-based cleanup levels are met at the FMC Site boundary and an acceptable risk level at any receptor including any that are located between the site boundary and the river. The MCLs for VOCs detected in one or more wells at the FMC Site are shown in Table 2 below.

Resource Conservation and Recovery Act (RCRA) (40 CFR Section 264.94)

The ROD cites that Background Levels, Listed Maximum Concentration Levels (LMCLs), and Alternate Concentration Levels (ACLs) (as defined by RCRA) are possible ARARs for the FMC Site. The ROD states that the MCLs have been selected as the relevant and appropriate cleanup standard and are identical to the LMCLs for the FMC Site COCs. It also states that MCLs would be appropriate as ACLs if it were necessary to establish ACLs (which it was not). The Background Level is that level of a chemical in the ground water in an area not impacted by contamination from a specific source. The ROD did not consider Background Levels.

There has been no change in the status of MCLs relative to LCMLs and ACLs; therefore, LCMLs and ACLs remain addressed by MCLs for the FMC Site COCs.

Federal Clean Water Act, 33 U.S.C. Section 1251, et seq., as amended

Requires U.S. EPA to establish water quality criteria for bodies of water, including ground water, based on the effects of pollutants on human health and aquatic life. Section 121 of CERCLA states that remedial actions shall attain these water quality criteria where they are relevant and appropriate under the circumstances of the release, based on the usage or potential usage of the water receiving the release.

The ambient water quality criteria for TCE cited in the document "Ambient Water Quality Criteria of Trichloroethylene," EPA 440'/5-80-077, October 1980 are 21,900 ug/l for the chronic aquatic life criterion and 45,000 ug/l for the final acute aquatic life criterion. The human health aquatic criterion for ingestion of contaminated surface water and contaminated aquatic organisms is 27 ug/l at the incremental increase of cancer risk over the lifetime at 1E-5.

Section 307 (b) of the Clean Water Act, Section 1317 (b) and regulations promulgated thereunder (40 CFR 403) require POTWs to develop and enforce treatment standards so as to prevent interference with operation of the POTW and pass through of the pollutants through the system. The current pretreatment permit limits to the POTW, MCES Special Discharge Permit No. 2020, are 3 mg/l for any single toxic organic and 10 mg/l for the total of all toxic organic compounds. In 2002, the TCE discharged into the POTW treatment system remained less than 1 mg/l and the total organic compound concentration remained at less than 1.3 mg/l.

To Be Considereds Cited in the ROD

Minnesota Department of Health Recommended Allowable Limits

MDH RALs were cited in the ROD as possible ground water cleanup levels that could be established where no MCL was established. The ROD cited RALs for the COCs. RALs have now been replaced by MDH HRLs, which are TBCs as explained below.

Minnesota Rules Parts 4717.7100 to 4717.7800

A HRL is the concentration of a ground water contaminant or mixture of ground water contaminants that can be safely consumed daily for a lifetime. A HRL is expressed as a concentration in parts per billion or calculated as a "hazard index."

The MDH developed HRLs using scientific risk assessment methods and data. The HRLs are calculated using the same methodology as for the "recommended allowable limits," which were advisory levels MDH used before the HRL rules were promulgated. HRLs apply to private ground water drinking water wells only. HRLs are not promulgated as cleanup ARARs, but are used by the MPCA as cleanup TBCs by agreement between the MPCA and the MDH. The HRLs replace all of the RALs cited in Table 1 of the ROD. The HRLs for VOCs detected in one or more wells at the FMC Site are listed in Table 2.

Table 2: MCLs and HRLs for COCs at the FMC Site

Compound	MCL (ug/l)	HRL (ug/l)
1,2-Dichloroethane	5	4
1,1-Dichloroethane	-	70
1,1,1-Trichloroethane	200	600
1,1,2-Trichloroethane	5	3
Tetrachloroethylene	5	7
Trichloroethylene	5	5*
Cis 1,2-Dichloroethylene	70	70
Trans 1,2-Dichloroethylene	100	100
1,1-Dichloroethylene	7	6
Vinyl Chloride	2	0.2
Carbon Tetrachloride	5	3
Benzene	5	10
Toluene	1,000	1,000
Ethyl Benzene	700	700
Xylenes	10,000	10,000
ug/l – Micrograms per liter		

* The HRL is 30 ug/l; however, MDH recommends an exposure limit of 5 ug/l based on new data since the HRL was established.

EPA Policy Memorandum, "Discharge of Wastewater from CERCLA Sites into POTWs," dated April 15, 1986

In order to safely discharge contaminated ground water from a Superfund site into a POTW, the ROD listed certain factors that had to be considered. These factors were

derived from an EPA policy memorandum, "Discharge of Wastewater from CERCLA Sites into POTWs," dated April 15, 1986. The factors are as follows:

1. Potential of pollutants to cause pass through or interference, including a health hazard to employees at the POTW.

2. The ability of the POTW to ensure compliance with applicable treatment standards and requirements.

3. The POTWs record of compliance with the NPDES permit and pretreatment program requirements.

4. The potential for volatilization of the wastewater and its impact upon air quality.

5. The potential for ground water contamination from transport of CERCLA wastewater to the POTW, and the need for ground water monitoring.

6. The potential effect of the CERCLA wastewaters upon the POTWs discharge into receiving waters.

The MPCA staff requested that the MCES re-evaluate the factors as they were evaluated in the ROD. MCES is the regulatory authority for the POTW into which the contaminated ground water from the FMC site is discharged In a letter from the MCES to the MPCA staff, dated November 16, 1998, the MCES stated that it "is not aware of any significant changes related to the six factors discussed in pages 29-32 [of the ROD]." MCES staff indicated in a December 30, 2003 phone interview they are not aware of any significant changes related to the six factors listed in the ROD.

Institutional Controls

The ROD cites a City of Fridley ordinance restricting private drinking water wells and MDH reviews of drinking water well locations to assure that no wells will be placed on lands over contaminated ground water from the FMC Site. The City of Fridley Building Code states in Chapter 206.01 that the city has adopted Chapter 4715, Minnesota Plumbing Code of the Minnesota State Building Code. Chapter 4715.0310, Minnesota Plumbing Code states that "If a public water supply system is accessible, the water distribution system must be connected to it unless otherwise permitted by the administrative authority." Mr. Jon Haukaas, City of Fridley Director of Public Works stated in a phone interview that municipal water is available in this area; therefore, new water users would be required to connect to the municipal water system based on the existing City of Fridley plumbing code. It is believed the City of Fridley ordinance restricting private drinking water wells referenced in the ROD may have actually been a reference to the plumbing code or other applicable code.

MDH and the City of Minneapolis require notification prior to installing a well. The MDH well code also places restrictions on well construction based on the geologic conditions. The combination of the plumbing code, the well installation notification requirements and the MDH well construction code appear to provide sufficient institutional controls to restrict well installation.

ARARs Not Cited in the ROD

Minnesota Rules Chapter 7060

Establishes uses and the nondegradation goal for ground water, as well as restoration of contaminated aquifers for use as potable water supply. This ARAR establishes a goal of returning contaminated ground water to potability for both public and private water supplies and reinforces using MCLs as ARARs where the ground water under the FMC Site and between the site boundary and the river would be used for public water supplies and reinforces using HRLs as TBCs in these same areas where the ground water would be used for a private water supplies.

Minnesota Rules Part 7050.0470, Subpart 4

The Mississippi River in the reach of the river where the contaminated ground water discharges is protected as a source of drinking water (Class 1B), for aquatic life and recreation (Class 2B), as well as for other, usually less sensitive uses (Classes 4, 5, and 6). This ARAR is important when evaluating the impact of discharge of the ground water plume into the river (see below discussion for Surface Water Quality Standards that apply to the Mississippi River.)

Minnesota Rules Parts 7050.0220, Subpart 4; 7050.0221, Subpart 4; and 7050.0222, Subpart 3

These ARARs establish the applicable water quality standards for TCE for this reach of the river which are:

Class	Concentration in µg/l
Class 1 (drinking water)	5
Class 2 (aquatic life):	
Chronic Standard	25
Maximum Standard	2,500* (6,988)
Final Acute Value	5,000* (13,976)

* a TBC, see explanation below

The most stringent applicable chronic standard is the 5 µg/l drinking water standard, and it is to be met at all locations in this reach of river. In Minnesota, the discharge of

pollutants to surface waters, including pollutants in ground water plumes, must be controlled to: (1) meet chronic water quality standards downstream; (2) prevent acutely toxic conditions in the effluent (ground water in this case) and mixing zone; and (3) meet minimum technology-based treatment requirements.

To Be Considereds Not in the ROD

In situations where the receiving stream provides ample dilution to a contaminated plume, such as at the FMC Site, meeting the chronic standard in the river is usually not a concern. However, the fact that the MWW intake is immediately downstream from the FMC Site and on the same side of the river is reason enough to apply an extra measure of caution in assessing the potential risks to human health at the site. With this consideration in mind, the policy of the MPCA regarding the FMC Site, is to require that the quality of ground water in the well(s) closest to the river, and any discharge of treated ground water to the river, meet chronic standards for COCs.

MPCA policy when dilution is adequate, and when extenuating circumstances are not involved, is to apply the maximum standard (2,500 µg/l for TCE) as the limit in the well closest to the surface water. The maximum standard for TCE is listed as 6,988 µg/l but is lowered to 2,500 µg/l under this same provision.

Remedy Implementation

The FMC Site ROD documented the EPA's selection of the RA for the FMC Site. The ground water RA includes an extraction well system with discharge of untreated ground water to the POTW and institutional controls for ground water usage on and around the FMC Site.

The ground water extraction system was constructed in 1987 and was placed into operation on December 7, 1987. The ground water extraction system, which originally consisted of five extraction wells (RW1 through RW5), was installed to remove contaminated ground water from the shallow, unconfined sand and gravel aquifer and the deep, confined sand aquifer. Extraction well RW1 was only pumped for one week before it was shut down due to insufficient recharge to facilitate ground water pumping. The ground water pumped from the four remaining extraction wells, RW2 through RW5, is discharged into the sanitary sewer for treatment at the Metropolitan Wastewater Treatment Facility, a POTW under an MCES permit. FMC and, since 1997, UDLP has maintained, operated and monitored the ground water extraction system from December 1987 through the present.

System Operations and Maintenance

FMC is performing ongoing operation, maintenance and monitoring for the ground water extraction system. The primary activities include the following:

- Weekly operational and equipment inspections;
- Monthly sampling and analysis of the discharge from the extraction wells to the sanitary sewer per the requirements of the discharge permit;
- Quarterly water level measurements at select monitoring wells;
- Quarterly sampling of the discharge from extraction wells RW2 and RW3 and semiannual sampling at RW4 and RW5;
- Sampling at the MWW water intake and at select monitoring wells;
- Routine maintenance as required by site specific conditions; and
- Submittal of an annual ground water monitoring report to the MPCA.

One major change in the extraction system operation was a proposal in September 2002 to increase the flow rate at RW3 and RW4. The existing one-horsepower submersible pumps at RW3 and RW4 were replaced with two-horsepower submersible pumps. The flow rate was increased in an attempt to maximize the capture zone in the confined aquifer based on an evaluation of aquifer testing performed during 2001 and a further evaluation of the data in 2002.

Routine maintenance at the ground water extraction system consists primarily of cleaning the pumps and the discharge piping and replacement of worn-out equipment. There have been no shut downs of the extraction system for a long enough period of time to adversely affect the remedial action. The system operation, maintenance and monitoring data are presented in an annual report that is submitted to the MPCA for review and comments.

The operation and maintenance costs were requested from Mr. Doug Hildre, Environmental Affairs Manager with UDLP. Mr. Hildre indicated they were not available.

V. PROGRESS SINCE THE LAST REVIEW

The last Five-Year Review, completed in 1999, contained several recommendations that are summarized as follows:

- Evaluate and modify the current monitoring well network,
- Evaluate the downgradient plume not captured by the ground water extraction system, and
- Evaluate additional methods to enhance the performance of the ground water extraction system to remediate source areas and to control the site plume.

Two monitoring wells were installed since completion of the last Five-Year Review. Monitoring well FMC-29A, which is screened in the confined aquifer, was installed on-site as a replacement for FMC-29. Monitoring well FMC-29 was properly abandoned because it was screened across the unconfined and confined aquifers. Monitoring well FMC-64, which is screened in the unconfined aquifer, was installed off-site to the west of RW2. There have been ongoing discussions between FMC, UDLP and the MPCA staff

regarding the installation of additional monitoring wells to correct problems with the existing monitoring network.

An aquifer test was performed in May 2001 to refine the previously calculated aquifer coefficients of transmissivity and storage for both the unconfined and confined aquifers. A capture zone analysis of the ground water extraction system was performed by FMC's consultant using the available data from monitoring and testing performed in 2001 and 2002. Subsequently, FMC installed larger submersible pumps at RW3 and RW4 with the intent of increasing the flow rate and enhancing the capture zone in the confined aquifer in the vicinity of these wells. The effectiveness of the increased flow rates at RW3 and RW4 on the capture zone are unknown at this time.

Ground water sampling and analysis was performed in May 2001 to evaluate whether the plume in the unconfined and confined aquifers are naturally attenuating. Based on the data, FMC's consultant stated that "reductive dechlorination of TCE is occurring in the unconfined aquifer in the southern half of the site." FMC's consultant further stated that additional enhancement of the ongoing reductive dechlorination process in the confined aquifer is a possible option but may not be cost effective.

FMC completed changes to the remedial system design since the last Five-Year Review. The revisions were implemented because of problems associated with a build up of iron bacteria in the discharge lines which restricted flow and to facilitate the proposed increase in the flow rate at RW3 and RW4. The changes included the installation of a two-horsepower submersible pump at RW3 and RW4, removal of the backflow preventers, relocation of the sample taps, installation of a suction break for backflow prevention, and installation of a flow totalizing display. New enclosures were constructed to provide better security and for ease of access. The changes do not appear to have affected the effectiveness of the RA. The MPCA staff has requested a copy of the as-built drawings. These drawings are not available at this time.

VI. FIVE-YEAR REVIEW PROCESS

Administrative Components

The Five-Year Review was initiated on October 13, 2003. The FMC representative was notified of the initiation of the Five-Year Review on October 27, 2003. The review components included:

- Community Involvement;
- Document Review;
- Data Review;
- Site Inspection;
- Local Interviews: and
- Five-Year Review Report Development and Review.

Community Involvement

Representatives of FMC, MWW, MCES and the City of Fridley were notified by a telephone interview that a five-year review was being performed. None of the contacted parties expressed a significant concern regarding the status and protectiveness of the remedy.

On February 26, 2004, a notice was published in the Fridley Columbia Heights Focus newspaper announcing that a Five-Year Review was being conducted for the FMC Site located in Fridley, Minnesota.

Document Review

This Five-Year Review consisted of a review of relevant documents including the ROD, additional assessment reports, annual monitoring reports (AMR), MPCA staff response letters and the previous Five-Year Review reports. A list of the documents reviewed are presented in the Bibliography (Appendix C).

Data Review

Ground water extraction has occurred since 1987 from RW2 through RW5. During 2002, over 47 million gallons of water was pumped from the extraction wells and discharged to the sanitary sewer. Over 700 million gallons of water have been pumped since system start-up in 1987.

The ROD states there are VOCs remaining in the unsaturated soils on the FMC and BNR property. The VOC concentrations detected at RW1 and RW2, which are completed in the shallow, unconfined aquifer along the southern portion of the site, would be a reflection of previous and ongoing impacts from the residual VOC concentrations in the unsaturated soil.

The highest concentrations of VOCs, including TCE, have generally been detected at RW2 based on data presented by FMC in the 2002 AMR. The TCE concentration at RW2 has decreased from a high of 91,000 ug/l in 1990 to an average concentration of 4,975 ug/l in 2002. The total organic volatile compound concentration at RW2 has decreased from 148,900 ug/l to an average concentration of 7,376 ug/l in 2002. The current and historical VOC concentrations at RW1 are unknown, because RW1 has not been operated since 1997 due to a lack of recharge into the extraction well.

Extraction wells RW3, RW4 and RW5, which are completed in the deeper, unconfined aquifer, have a lower TCE concentration. The highest TCE concentration in the deeper wells has historically been detected in RW5. The TCE concentration at RW5 has decreased from a high of 2,000 ug/l to an average concentration of 155 ug/l in 2002.

Laboratory analysis has detected additional VOCs in ground water samples collected from the extraction wells and monitoring wells. A partial list of the VOCs detected at RW2 and a representation of the concentrations is presented in Table 3.

Table 3: Detected VOCs and Concentrations at RW2

Compound	MCL (ug/l)	HRL (ug/l)	Concentration (Range 1999 – 2002) (ug/l)	Concentration (Last sample in 2002) (ug/l)
1,2-Dichloroethane	5	4	ND - 2.2	2.2
1,1-Dichloroethane	-	70	6.7 – 37	21
1,1,1-Trichloroethane	200	600	56 – 870	470
1,1,2-Trichloroethane	5	3	ND – 2.2	1.6
Tetrachloroethylene	5	7	ND – 140	76
Trichloroethylene	5	5*	1,800 – 6,800	3,900
Cis 1,2-Dichloroethylene	70	70	510 - 2,900	840
Trans 1,2-Dichloroethylene	100	100	3 - 12	6.4
1,1-Dichloroethylene	7	6	1.9 – 14	8.0
Vinyl Chloride	2	0.2	ND – 50	24
Carbon Tetrachloride	5	3	ND – 110	58
Benzene	5	10	ND – 0.61	ND
Toluene	1,000	1,000	ND - 6	4.5
Ethyl Benzene	700	700	1.6 – 8.3	8.2
Xylene	10,000	10,000	3.3 – 20.7	15.8
ug/l – Micrograms per liter				
*The HRL is 30 ug/l, although MDH recommends an exposure limit of 5 ug/l based on new data since the HRL was established				
ND – Not detected at or above the laboratory reporting level				

FMC calculated and reported in the 2002 AMR that over 568 pounds of VOCs, containing 421 pounds of TCE were removed from the ground water in 2002. Since initiation of ground water extraction in December 1987, FMC calculated that over 16,700 pounds of VOCs, which contain over 14,260 pounds of TCE have been removed from the ground water.

Ground water sampling and analysis is performed at selected monitoring wells located both on-site and off-site. The wells are completed in the shallow, unconfined sand aquifer and in the deeper, confined sand aquifer. The majority of off-site monitoring wells are constructed with long screened intervals that prevent accurate collection of hydraulic head and plume chemistry data. The MPCA has identified these deficiencies in the off-site monitoring well network data to FMC and UDLP in numerous written MPCA review responses to FMC Site documents. Due to these monitoring deficiencies, accurate off-site equipotential and plume maps cannot be constructed and are not included in this review. The MPCA is currently working with FMC and UDLP to resolve these deficiencies and improve the off-site monitoring well network.

Laboratory analysis has detected additional VOCs in the ground water samples collected from the monitoring wells at both on-site and off-site locations. It is difficult to evaluate concentration trends for VOCs other than TCE because the concentrations are not presented in tabular form. A review of the data presented in the appendices of the 2002 AMR indicates that additional VOCs besides TCE were detected in at least one monitoring well in a concentration at or above the MCL. The additional compounds include tetrachloroethylene, vinyl chloride, 1,1-dichloroethane, 1,2-dichloroethane, 1,1-dichloroethylene, cis 1,1-dichloroethylene, and 1,1,1-trichloroethane.

The horizontal gradient is generally to the west by southwest towards the Mississippi River in the unconfined and confined aquifers. The horizontal gradient has remained consistent since the inception of monitoring.

A capture zone analysis of the ground water extraction system was performed by FMC's consultant using the available data from monitoring performed in 2001 and 2002. The analysis concluded that "the recovery well spacing may not be capturing groundwater between RW3 and RW4. However, monitoring of the dissolved phase contaminant plume indicates the groundwater between RW3 and RW4 may not require capture due to a lack of highly contaminated groundwater as observed at MW-29/MW-29A." On September 5, 2002, FMC proposed to increase the pumping rates at RW3 and RW4. The proposal was approved by the MPCA staff on September 10, 2002. The effectiveness of the increased flow rates at RW3 and RW4 on the capture zone are unknown at this time.

Monitoring well FMC-21 is used to sample the unconfined aquifer before the FMC plume discharges to the Mississippi River. In 2001, the TCE concentration in FMC-21 was 120 ug/l, which exceeded the surface water ARAR of 5 ug/l for TCE by 24 times. In 2002, the TCE concentration in the well was less than 0.5 ug/l. The TCE concentration in this well has fluctuated for years. FMC has acknowledged that the well yield is suspect and should be abandoned and replaced with another monitoring well to monitor the unconfined aquifer plume prior to discharge to the river.

A water sample collected during October 2002 from a discharge along the eastern bank of the Mississippi River contained 35 ug/l of TCE. The spring or seep is only visible during periods of low flow. The discharge is located between monitoring wells FMC-20 and FMC-21.

Low to non-detectable concentrations of VOCs have historically been documented in water samples collected from the Mississippi River at the MWW. No exceedance of the MCL for TCE has been documented at the MWW intake during the review period.

Site Visit

Site visits have been conducted periodically throughout the review period; however, a site visit was conducted on November 4, 2003 as part of the Five-Year Review process. The monitoring wells and recovery wells referenced in this document are in place and

contaminated ground water was observed being pumped into the POTW collection system.

Interviews

Interviews were conducted with various parties connected to the site. Mr. Jon Haukass, Fridley Director of Public Works, was contacted on December 11, 2003 as part of the community notification task and to inquire about the well restriction institutional control. Mr. Haukass was not aware of a specific city ordinance restricting well development on the FMC property or the property to the west. He did indicate the city plumbing code requires water users to connect to the existing municipal water supply system. Mr. Haukass said he has not received any specific complaints or comments from the public regarding the ongoing remedy at the FMC Site.

An interview was conducted on December 11, 2003 with Mr. Mike Convery, with the MDH, regarding the MDH well notification and installation requirements. Mr. Convery stated that the City of Minneapolis and MDH have notification requirements prior to installation of a well. Also, MDH has well construction requirements which would restrict the installation of a shallow potable well in this area based on the geology and the known contamination.

Mr. Doug Hildre, Environmental Affairs Manager with UDLP, was interviewed on December 16, 2003. His overall impression was the remedy was protective, although he acknowledged differences with MPCA staff regarding the effectiveness of the monitoring well network.

Mr. Larry Cole, MWW Supervisor of Water Treatment and Laboratory, was interviewed on December 30, 2003. Mr. Cole did not express any concerns or issues associated with the remedy.

An interview was conducted on December 30, 2003 with Mr. Mike Flaherty, Senior Engineer with MCES, regarding the discharge to the POTW. Mr. Flaherty indicated the discharge from the FMC Site is meeting the requirements of the permit. He was not aware of any significant changes related to the six factors listed in the ROD. He did comment that MCES is always interested in limiting the duration of a significant discharge volume such as this and the overall affect on the operating capacity at the POTW.

VII. TECHNICAL ASSESSMENT

Question A: Is the remedy functioning as intended by the decision documents?

In general, the remedy is functioning as intended although questions remain regarding the effectiveness of the remedy. The ground water extraction system continues to remove VOCs from the unconfined and confined aquifers. However, it is impossible to evaluate

the efficiency of the plume capture, downgradient plume conditions and compliance with ARARs based on the existing monitoring network and the data presentation in the annual monitoring report.

The flow rate was increased at RW3 and RW4 in September 2002 in an attempt to enhance the capture zone and minimize off-site plume migration in the confined aquifer. The data collected from September through December 2002, and presented in the 2002 AMR, is not sufficient to evaluate the effectiveness of the increased flow rate on plume capture and ground water quality.

The remedial goal of 5 µg/l TCE at the property boundary has not been achieved at the FMC Site for either the unconfined or confined plumes. TCE concentrations greater than 5 µg/l were detected in off-site monitoring wells. Additional VOCs were detected in the off-site monitoring wells in concentrations greater than their respective MCL or HRL. It is expected that VOC removal due to pumping of contaminated ground water has reduced off-site migration of VOCs; however, deficiencies in the downgradient monitoring well network makes it difficult to evaluate the condition of the downgradient plumes.

As discussed in the last Five-Year Review, the existing monitoring well network is not adequate to evaluate the effectiveness of the remedy. This is both a reflection of the well construction, i.e., screen length for the wells completed in the confined aquifer and the positioning of the monitoring wells in the confined and unconfined aquifers. The presence of wells in the confined aquifer with screen lengths of 70 to 100 feet raises issues regarding data interpretation pertaining to vertical characterization of hydrologic conditions and ground water quality. The number and placement of monitoring wells to the west and southwest of RW2 and adjacent to FMC-64 appears to be inadequate to evaluate off-site plume migration in the unconfined aquifer. Fluctuations in the TCE concentration at off-site wells FMC-21 and FMC-54 also raises questions regarding the adequacy of the monitoring network.

Low to non-detectable concentrations of VOCs have historically been documented in water samples collected from the Mississippi River at the MWW. The exceedance of the MCL for TCE and for other COCs has not been documented at the MWW intake during the review period.

A water sample collected from a spring or seep along the east bank of the Mississippi River in October 2002 contained 35 ug/l. The TCE concentration at FMC-20 was 68 ug/l in the October 2002 sample. The TCE concentration at FMC-21 has varied considerably in recent years. Based on this data, it appears that the surface water quality standard for TCE for the Mississippi River may not be met.

The system has been in operation for over 16 years. There do not appear to be operation and maintenance issues that have adversely affected the ground water extraction and treatment system.

The institutional controls appear to be adequate to prevent ground water development and usage on the FMC site and the property to the west between the site and the Mississippi River in the area of the ground water plume.

Question B: Are the exposure assumptions, toxicity data, cleanup levels, and remedial action objectives (RAOs) used at the time of the remedy selection still valid?

Most of the ARARs and the TBCs established at the time of the remedy selection have not changed and are still valid. The MCL for tetrachloroethylene has decreased from 10 ug/l to 5 ug/l. A separate MCL has been established for cis 1,2-dichloroethylene (70 ug/l) and trans 1,2-dichloroethylene (100 ug/l). The MDH has promulgated HRLs for several of the COCs listed in the ROD. The current MCLs and HRLs are listed in Table 2, which is presented in Section IV.

Question C: Has any other information come to light that could question the protectiveness of the remedy?

There have been some physical changes to the ground water remedy at the FMC Site since completion of the last five-year review. However, the changes do not appear to have affected the effectiveness of the remedy. There is no other information that calls into question the protectiveness of the remedy.

VIII. ISSUES

Table 3 - Issues

Issue	Currently Affects Protectiveness (Y/N)	Affects Future Protectiveness (Y/N)
Inadequate data to determine if the revisions to the pumping rate have increased the efficiency of the capture zone.	Y	Y
Inadequate monitoring network to evaluate the off-site migration of the plume in the confined and unconfined aquifers.	Y	Y

IX. RECOMMENDATIONS

The ground water extraction remedy is removing VOCs from the unconfined and confined aquifers. It is recommended that the ground water RA continue; however, there are ongoing issues that make it difficult to evaluate the effectiveness of the existing ground water remedy. The following recommendations are:

- A further definition of the lateral and vertical magnitude and extent of the contaminant plume in the unconfined and confined aquifers is necessary as outlined in the MPCA letter dated June 2, 2003.

- The off-site monitoring network should be evaluated after the lateral and vertical magnitude and extent of the contaminant plumes have been defined. Modifications to the monitoring well network should be proposed and implemented. The well network should monitor the lateral and vertical magnitude and extent of the off-site plumes, the effectiveness of the ground water capture system in preventing the off-site migration of contaminant plumes, the progress of the ground water cleanup in achieving cleanup goals and should evaluate potential exceedances of the surface water standards prior to plume discharge to the Mississippi River.

- A further evaluation of the effectiveness of the increased pumping rate at RW3 and RW4 on the capture zone and plume migration is needed.

- An evaluation should be performed to determine if the existing remedial system is capturing contamination at and downgradient of RW1.

- The ROD specifies that "the effectiveness of the ground water pump-out and treatment system will be assessed through monitoring of receptors, ground water levels, ground water contaminant concentrations, and discharge to the sanitary sewer." Utilizing the data from the modified monitoring well network, a more detailed data presentation and interpretation should be included in the AMR, to assist in the evaluation of the effectiveness of the remedy. The additional data presentation should include, but not be limited to, concise and legible tables, tables with all of the detected VOCs with their respective HRLs and MCLs, isoconcentration maps for the two aquifers, equipotential maps, capture zone maps, etc. In addition to additional data presentation, the AMR should include a concise and informative interpretation of the data to assist the reader in evaluating the effectiveness of the remedy.

- If data from the modified monitoring well network indicates the current remedy does not meet cleanup goals, or if data indicates that protectiveness is not achieved, modifications to the current remedy or alternative remedial actions should be proposed and implemented conditional on regulatory approval of such changes.

- The recommendations listed above should be addressed as soon as possible, and certainly soon enough that the effectiveness of the implemented recommendations can be evaluated in the next five-year review.

X. PROTECTIVENESS STATEMENT

The remedy is functioning as intended and is protective of human health and the environment in the short-term. Long-term protectiveness needs to be verified based on the

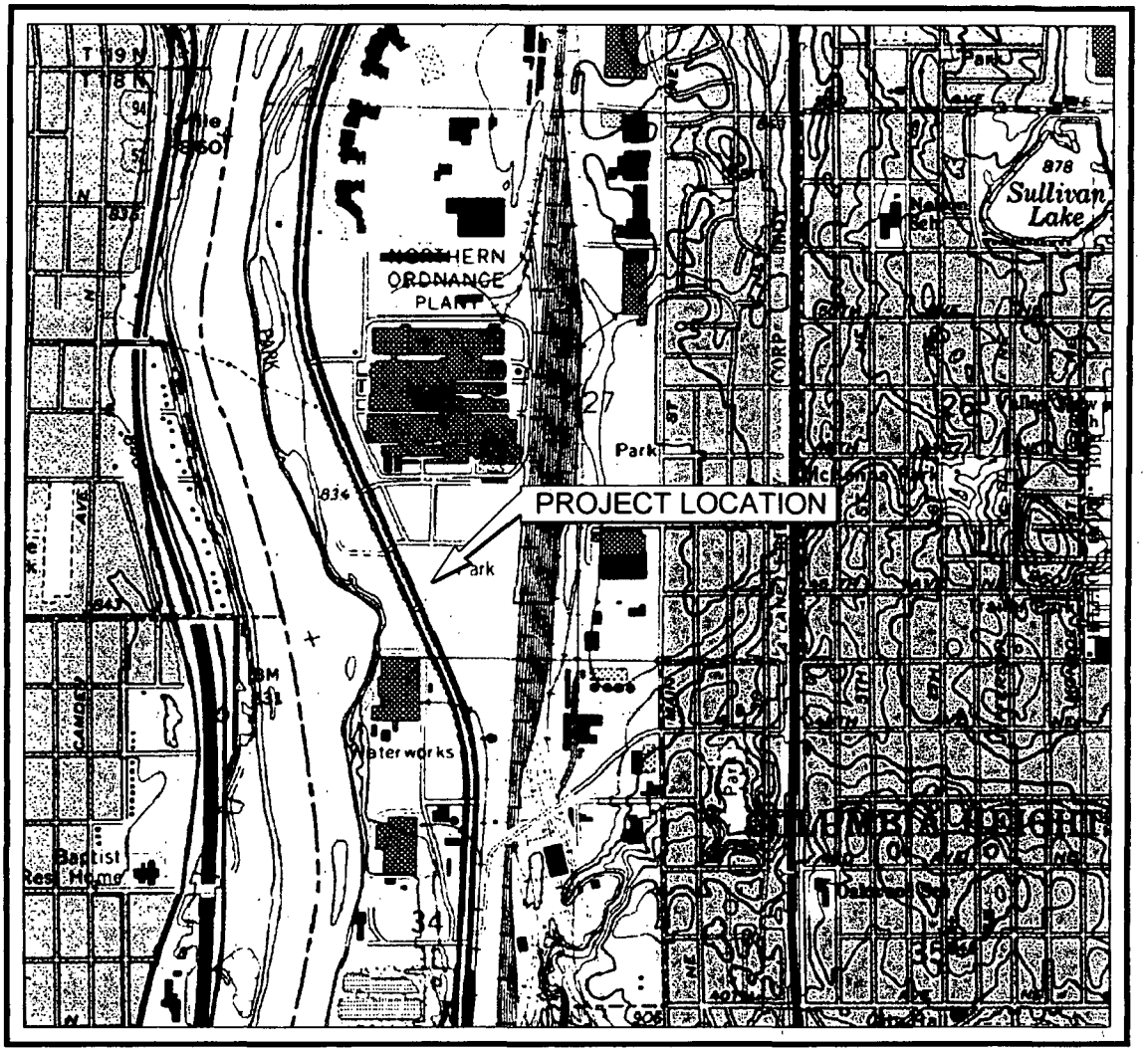
follow-up actions and recommendations. The remedy would be confirmed to be fully protective if recommendations cited in Section IX are implemented so that it can be determined that the performance requirements of the remedy cited in Section IV are being met.

XI. NEXT REVIEW

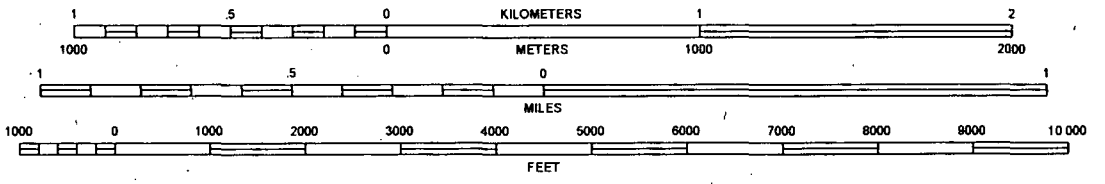
Hazardous substances, pollutants, or contaminants will remain at the FMC Site that will not allow for unlimited use or unrestricted exposure. EPA or the MPCA, if delegated to do so by EPA, will conduct another Five-Year Review by March 30, 2009.

APPENDIX A

UNITED STATES - DEPARTMENT OF THE INTERIOR - GEOLOGICAL SURVEY



SCALE 1:24 000



MINNEAPOLIS NORTH QUADRANGLE

MINNESOTA - HENNIPEN COUNTY

7.5 MINUTE SERIES (TOPOGRAPHIC)

SITE LOCATION MAP

FMC SITE

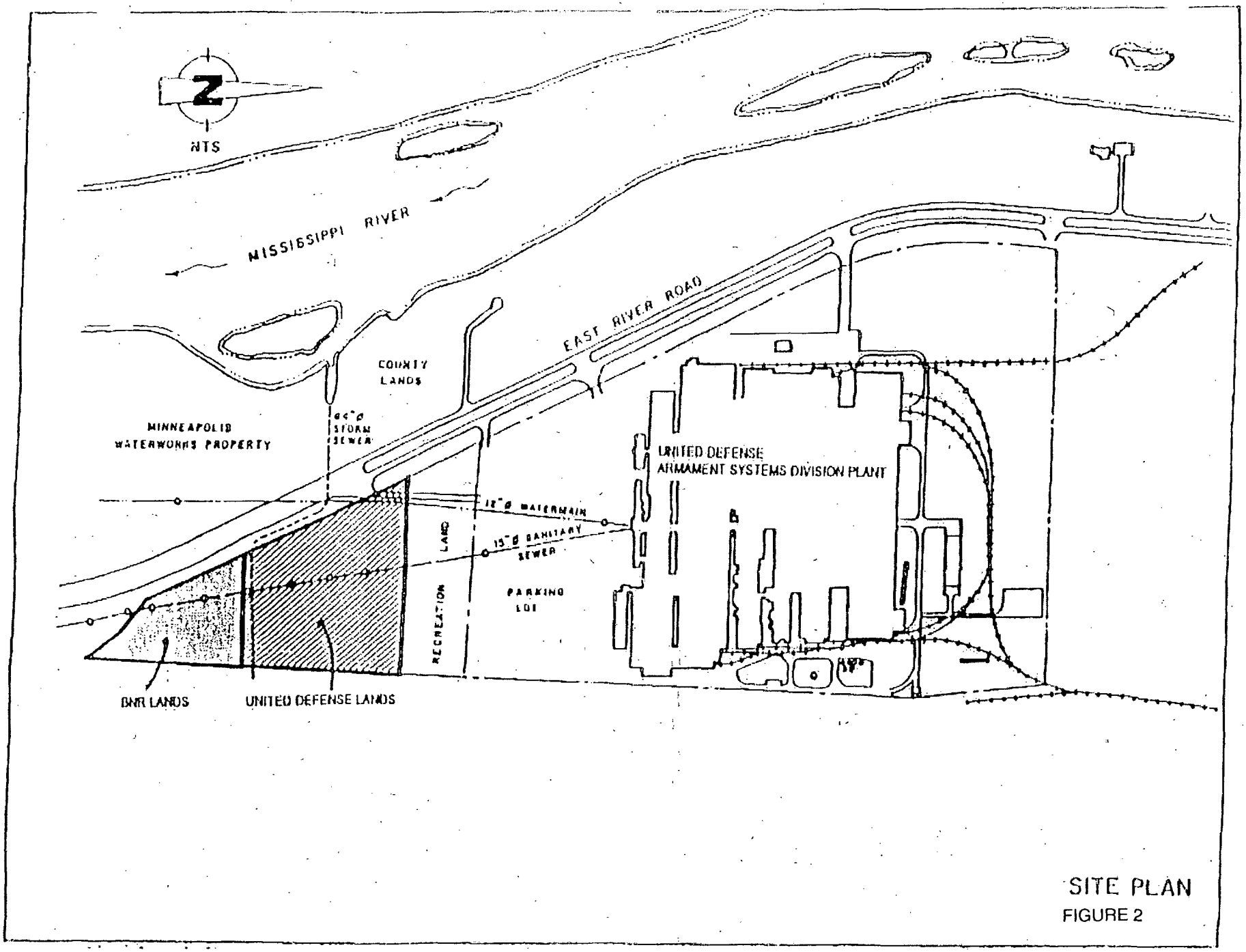
EAST RIVER ROAD

FRIDLEY, MN

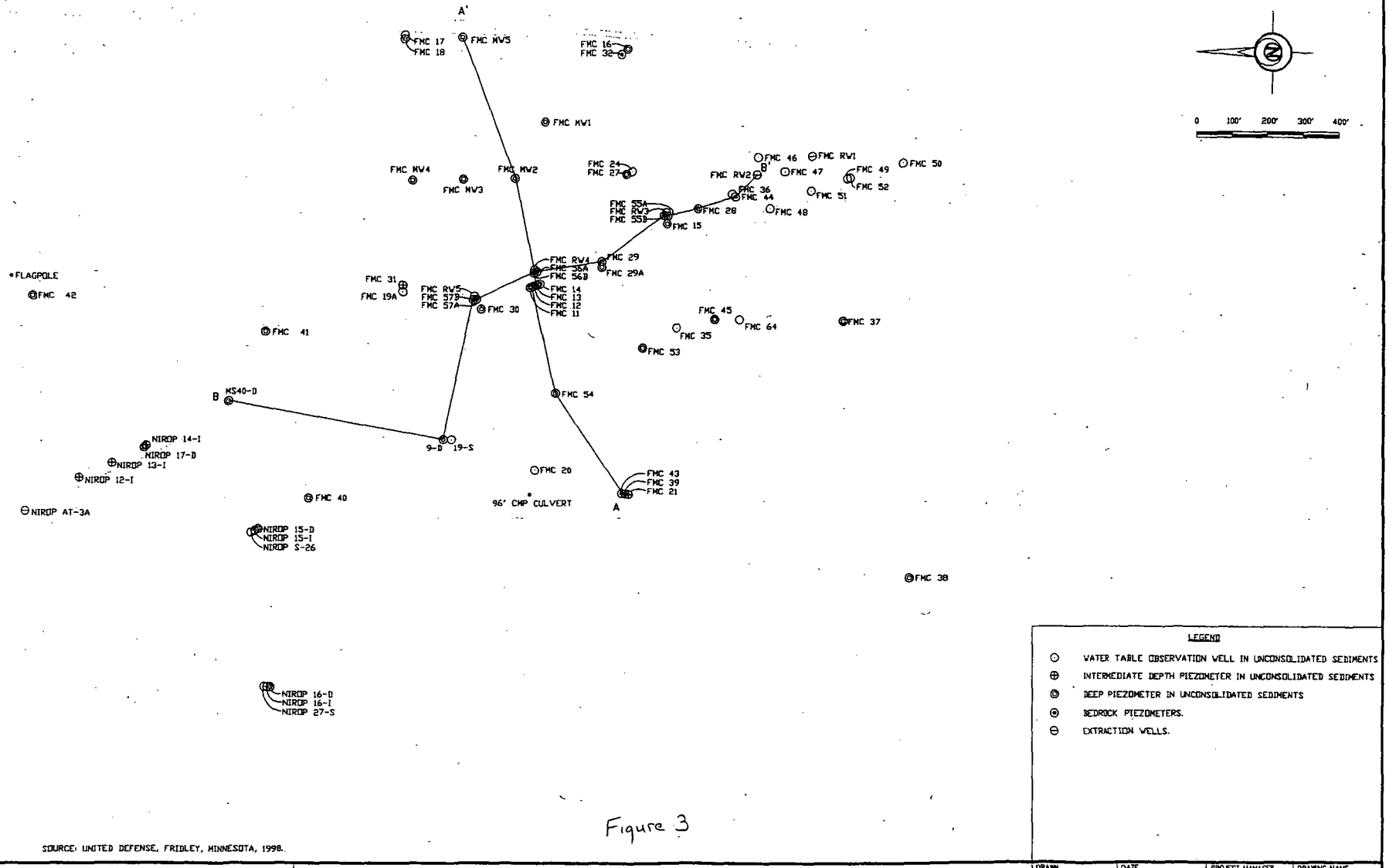
MPCA

Project Mngr:	WJB	Terracon	Project No. 41037084
Designed By:	WJB		Scale: AS SHOWN
Checked By:	WJB	3535 Hoffman Road East White Bear Lake, MN 55110	Date: 12/30/03
Approved By:	WJB		Drawn By: CDR (41)
File Name:	41037084sl.dwg TOPO		Figure No. 1

DIAGRAM IS FOR GENERAL LOCATION ONLY,
AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES



SITE PLAN
FIGURE 2



LEGEND

- ⊙ WATER TABLE OBSERVATION WELL IN UNCONSOLIDATED SEDIMENTS
- ⊕ INTERMEDIATE DEPTH PIEZOMETER IN UNCONSOLIDATED SEDIMENTS
- ⊚ DEEP PIEZOMETER IN UNCONSOLIDATED SEDIMENTS
- ◉ BEDROCK PIEZOMETERS.
- ⊖ EXTRACTION WELLS.

Figure 3

SOURCE: UNITED DEFENSE, FRIDLEY, MINNESOTA, 1998.

ARCADIS

LOCATIONS OF GEOLOGIC CROSS SECTIONS
FORMER FMC SITE
FRIDLEY, MINNESOTA

DRAWN	DATE	PROJECT MANAGER	DRAWING NAME
RS/DN	2 August 01	DLR	Contours
		LEAD DESIGN PROF.	CHECKED
		RS	RS
		PROJECT NUMBER	FIGURE NUMBER
		MN00428.03	3

APPENDIX B

Attachment 1
Monitoring Data
FMC Site
Fridley, Minnesota

Sample Location	Average Conc.	7/21/1981	10/14/1981	11/12/1981	12/1/1981	10/21/1982	12/1/1982	1/10/1983	3/28/1983	5/28/1985	12/15/1987	11/3/1988	11/8/1989	10/9/1990	10/10/1991	10/14/1992	10/14/1993	10/12/1994	10/13/1995	10/9/1996	10/20/1997	10/31/1998	11/1/1999	10/26/2001	10/30/2002
FMC-11	228	230	303	411	404	163				160				61	90										4.8
FMC-12	257	200	267	325	383					110														10	3
FMC-13	8	7	4	7	10					10															
FMC-14	1075	1250	3486	2200	1974	1880	780	680	411	880						1200	780	230	460	290	530	290	950	520	230
FMC-15	8521		11392	10838	34522	13000	24000	10900	27600	8100				540	790	340	1100	220	340	400	*400	340	430	670	770
FMC-16	2		0	8	1					0															
FMC-17	25		0	6	0					0										1.7	180	9.5	0.38	0.22	0
FMC-18	0		0	0	0					0.3															
FMC-19a	1			0	2	1	1	3	1	0															
FMC-20	26		0	2	6	3	3	1	9	0											7.3	170	86	96	68
FMC-21	25					23	10	4	150	31	22	21	52	35	9.3	2.6	10.8	0	3.4	3.4	72	2.1	0.89	120	0
FMC-24	120					141	183	201	159										120			11	27	28	7.7
FMC-27	2					1	1	1	2											0	6	4.2	1.3		
FMC-28	1						1	1	2	0.3														0.57	0
FMC-29	8						28	21	4	6							5.8	0	0	0					
FMC-29A																								5.5	4.9
FMC-30	469						1720	1530	2290	31				190	210	190	37	14	24	16	120	110	86	58	47
FMC-31	1781						74	6969	74	6.4															
FMC-32	10						11	10	15	5.4															
FMC-33																									
FMC-34																									
FMC-35	68									160										7.1	36	130	5.4	2.1	0
FMC-36	9550									4900					28000	17000	2000	900	1200	750	*5300	5200	26000	38000	18000
FMC-37	4									0				7	5.8	5.4						2.7	3.0	2.4	2
FMC-38	12									31												2.0	1.8	3.5	2.8
FMC-39	16									6.8	56	50	24	26	24	12	0	0	0	0	15	5.6	2.3	1.4	0
FMC-40	26									26															
FMC-41	0									0															
FMC-42																									
FMC-43	7									7															
FMC-44	3									0							8.2	0	2.7	2.4	9.4	2.1	1.9		
FMC-45	162									430				230	230	280	120	42	99	41	95	110	100	78	57
FMC-46	53726									56000						190,000	150,000	13,000	46,000	9,000	19,000	220	310	51	7.2
FMC-47																				350	500	30	46	62	100
FMC-48	61									130										25	130	11	8.4	14	
FMC-49																								0	
FMC-50	164									0.321				380	610	440	150	63	60	31	58	6.0	4.6	10	3.3
FMC-51																				120	210	130	160	66	45
FMC-52	54													22						34	120	72	24	33	82
FMC-53	2																0	0	0		7.3	2.0	2.5	16	6.9
FMC-54	166													86	200	230	4.4	0	3.7	33	260	430	410	480	230
FMC-64																								41	62
MPLS INTAKE	0											0	0	0	0	0	0	0	0	0	0	0.56	0	0	0
TCE DL (ug/L)														2.1	2.1	2.1	2.1	2.1	2.1	2.1	0.16	0.5	0.5	0.5	0.5

* Data at well 15 and 36 not originally validated due to sample identification error. Validated results listed are from samples taken April 15, 1998.
TCE ug/L by EPA Method 624/8240, Not detected represented by Zero

APPENDIX C

BIBLIOGRAPHY

U.S. Environmental Protection Agency, September 30, 1987, "Superfund Record of Decision, FMC Corporation, MN, Second Remedial Action - Final"

Five-Year Review Report, FMC Corporation Site, Fridley, Minnesota dated September 30, 1992

January 15, 1998, Results of Environmental Investigation at proposed BNSF Northtown Stormwater Retention Pond - Fridley, MN (1-3795-300), ThermoRetec Corporation

Groundwater Extraction System Annual Monitoring Report For 1997, United Defense LP, June 1998

Five-Year Review Report, FMC Corporation Site, Fridley, Minnesota dated March 30, 1999

Groundwater Extraction System Annual Monitoring Report For 1998, United Defense LP, June 1999

September 28, 1999, Public Health Assessment, Naval Industrial Reserve Ordnance Plant, Fridley, Anoka County, MN, CERCLIS No. MN3170022914, U.S. Department of Health and Human Services, Public Health Service

Groundwater Extraction System Annual Monitoring Report For 1999, United Defense LP, June 2000

Work Plan for Site Work to Complete Tasks 1 and 2, United Defense, Fridley, MN, July 27, 2000, Arcadis Geraghty & Miller

September 8, 2000 letter from MPCA that is a response to the "Groundwater Extraction System Annual Monitoring Report for 1999", dated June 2000

Revised Work Plan for Site Work to Complete Tasks 1 and 2, Former FMC Site, Fridley, MN, March 15, 2001, Arcadis Geraghty & Miller

Groundwater Extraction System Annual Monitoring Report For 2000, United Defense LP, June 2001

Results of Site Work Conducted in May 2001, Former FMC Site, 4800 East River Road, Fridley, MN, November 19, 2001, Arcadis Gerathy & Miller

Groundwater Extraction System Annual Monitoring Report For 2001, United Defense LP, June 2002

June 25, 2002 letter from MPCA that is a response to the "Groundwater Extraction System Annual Monitoring Report for 2000", dated June 2001

September 5, 2002 letter from United Defense LP entitled, Modifications to Groundwater Extraction System
September 10, 2002 letter from MPCA approving the proposed modifications to the ground water extraction system

Groundwater Extraction System Annual Monitoring Report For 2002, United Defense, L.P./FMC Corporation, June 2003

June 2, 2003 letter from MPCA, that is a response to the "Results of Site Work Conducted in May 2001", dated November 2001

June 2, 2003 letter from MPCA that is a response to the "Groundwater Extraction System Annual Monitoring Report for 2001", dated June 2002

September 3, 2003 memorandum from Arcadis entitled, Response to MPCA Comments Dated June 2, 2003

September 5, 2003 letter from Arcadis entitled, Work Plan for Monitoring Well Installation

September 8, 2003 letter from United Defense LP that included as attachments the September 3 and 5, 2003 correspondence from Arcadis

November 7, 2003 letter from MPCA that is a response to the "Groundwater Extraction System Annual Monitoring Report for 2002", dated June 2003